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NAVORD REPORT 4464

DA[illegible]NG TESTS OF SEVERAL PROPOSED CONFIGURATIONS OF PROJECT HOTPOINT (U)

15 DECEMBER 1958

U. S. NAVAL ORDNANCE LABORATORY
WHITE OAK, MARYLAND

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Aeroballistic Research Report 371

DAMPING TESTS OF SEVERAL PROPOSED CONFIGURATIONS OF PROJECT HOTPOINT

Prepared by:

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ABSTRACT: Results are presented ~~in this~~ report of a wind-tunnel investigation conducted to obtain damping-in-pitch measurements of several proposed configurations of Project Hotpoint. The models were tested at Mach numbers 0.90 and 0.93. The unfaired mine shape indicated no damping below ten degrees angle of attack and the two faired shapes trimmed at ten degrees angle of attack.

U. S. NAVAL ORDNANCE LABORATORY
White Oak, Silver Spring, Maryland

NAVORD Report 4464 December 15, 1958

This is a report on an investigation of the damping of three proposed versions of Project Hotpoint. This test was performed at the request of the Underwater Ordnance Department (reference (a)) and was performed under task number 732-566/62001/01.

MELL A. PETERSON
Captain, USN
Commander

R. KENNETH LOBB
By direction

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ILLUSTRATIONS

DAMPING TESTS OF SEVERAL PROPOSED CONFIGURATIONS OF PROJECT HOTPOINT

INTRODUCTION

1. Hotpoint is a bomb that is being developed by the Naval Ordnance Laboratory for the Bureau of Ordnance.

2. Damping-in-pitch data were obtained at Mach numbers 0.90 and 0.93 on three proposed versions of the Hotpoint weapon.

Symbols

$C_{M_q} + C_{M_{\dot{\alpha}}}$	damping coefficient ($-16/\pi\ K_H$)
d	maximum diameter (1.80 inches)
I	transverse moment of inertia about the center of gravity (slugs-ft^2)
K_H	ballistic damping coefficient ($\mu/\rho V d^4 = -\pi/16(C_{M_q} + C_{M_{\dot{\alpha}}})$)
q	dynamic pressure (see Table I)
Re	Reynolds number (see Table I)(based on model length)
t	time (seconds)
V	velocity (ft/sec)
α	angle of attack (degrees)
ρ	air density (slugs/cu. ft.)
μ	damping coefficient ($-2\ I\ (\log \alpha/\alpha_o)\Delta t$)

Description of the Models and Instrumentation

3. The models were dynamically balanced about the scaled full-scale center of gravity. A shaft whose axis was normal to the longitudinal axis of the model was passed through the center of gravity and was attached to the model by means of precision ball bearings of very low frictional torque. The models were thus able to rotate in the pitch plane about a transverse axis which passes through the center of gravity.

4. The models tested were an internal store shape and two external store shapes. The external store shapes differed in length of fin chord. Photographs of the models are shown in Figures 1, 2, and 3 and sketches of the models are shown in Figures 4, 5, and 6. All dimensions are in inches.

5. The external store body is similar to the Navy Low-Drag Bomb in appearance. The fins on the external store are swept-wing in planform and are double wedge in cross-section. The test conditions and model physical characteristics are given in Table I. The model dimensions given in Table I are the actual measured dimensions. The dimensions shown in Figures 4, 5, and 6 are the scale dimensions from the full scale hardware.

Data Reduction

6. The model is rotated about the center of gravity and the wind tunnel is turned on. The motion of the model is photographed with a 16 mm movie camera. The data reduction technique is described in detail in reference (b). Briefly the data reduction consists of two phases: reading the film and fitting an envelope to the data obtained from the film. From the film the angle of the model is obtained for each frame of film using a comparator. The time record is obtained from the camera speed (64 frames per second). The angular deflection plotted against time yields a damped sine motion. The envelope of the motion is faired. In true harmonic damping, this envelope would be of the form $\alpha = \alpha_o e^{-\mu t/2I}$. Damped harmonic motion requires that the restoring moment be linear; this is not always the case. However, by assuming the harmonic condition for small increments along the envelope, the damping coefficient (μ) can be obtained as a function of angular deflection by obtaining an average μ for an average angle. The damping coefficient (μ) is related to K_H by the equation.

$$K_H = \frac{\mu}{\rho V d^4}$$

RESULTS

7. The internal store shape exhibited dynamic stability in pitch above angles of attack of 10 degrees but has none at angles below 10 degrees.

8. Both of the external store models were stable but both trimmed at angles of attack of $\pm$ 10 degrees. There was a large change in frequency with angle of attack which indicates a non-linear restoring moment.

9. The results are tabulated in Table II.

References

(a) Seigel, A., Wind-Tunnel Request (WTR 314) (Conf.) 1955
(b) Shantz, I., and R. T. Groves, "Subsonic Damping-in Pitch Measurements of the EX-10, EX-30, and 6" Test Vehicle", NAVORD Report 4025, (Conf.)

Test Conditions and Model Information

TABLE I*

Model	Length Cal.	Center of Gravity (calibers from tail)	Mach No.	Re x 10^{-6}
Unfaired	3.59	2.28	0.90	2.5
Faired-short chord	8.15	4.71	0.90	5.5
Faired-long chord	8.15	4.71	0.93	5.5

* NOTE: Dimensions are measured values and may vary slightly from dimensions given in Figures 4, 5, and 6 which give the design dimensions.

Tabulated Data

TABLE II

Model	Mach No.	α Degrees	$C_{M_q} + C_{M_{\dot{\alpha}}}$
Unfaired	0.90	32.7	38.5
		25.4	33.4
		20.7	25.2
		17.3	25.9
		14.8	19.6
Faired-Short Chord	0.90	19.5	100.0
		16.7	104.6
		14.5	96.7
Faired-Long Chord	0.93	23.7	173.9
		19.4	121.5
		16.8	95.8

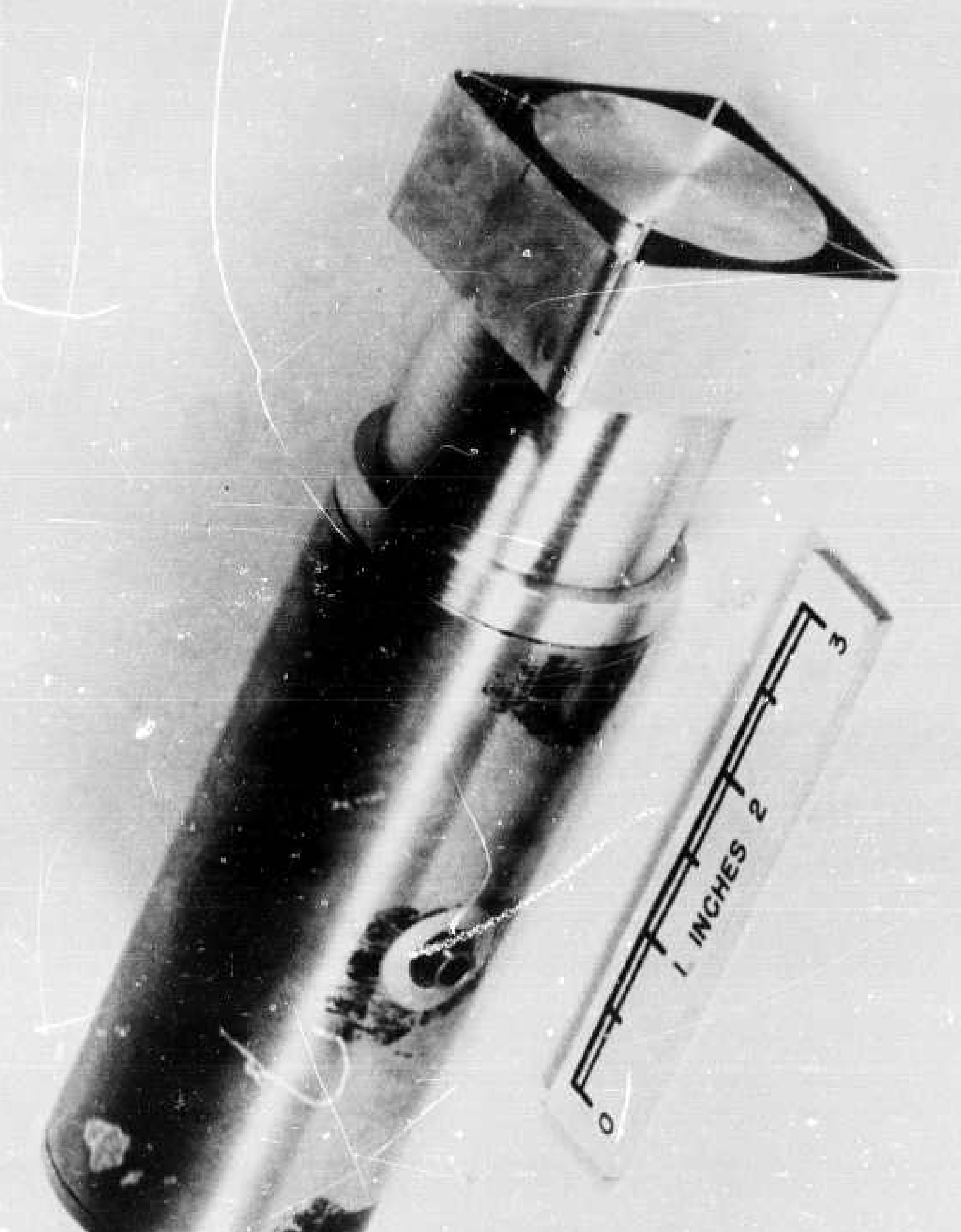

FIG. 1 HOTPOINT MINE SHAPE MODEL

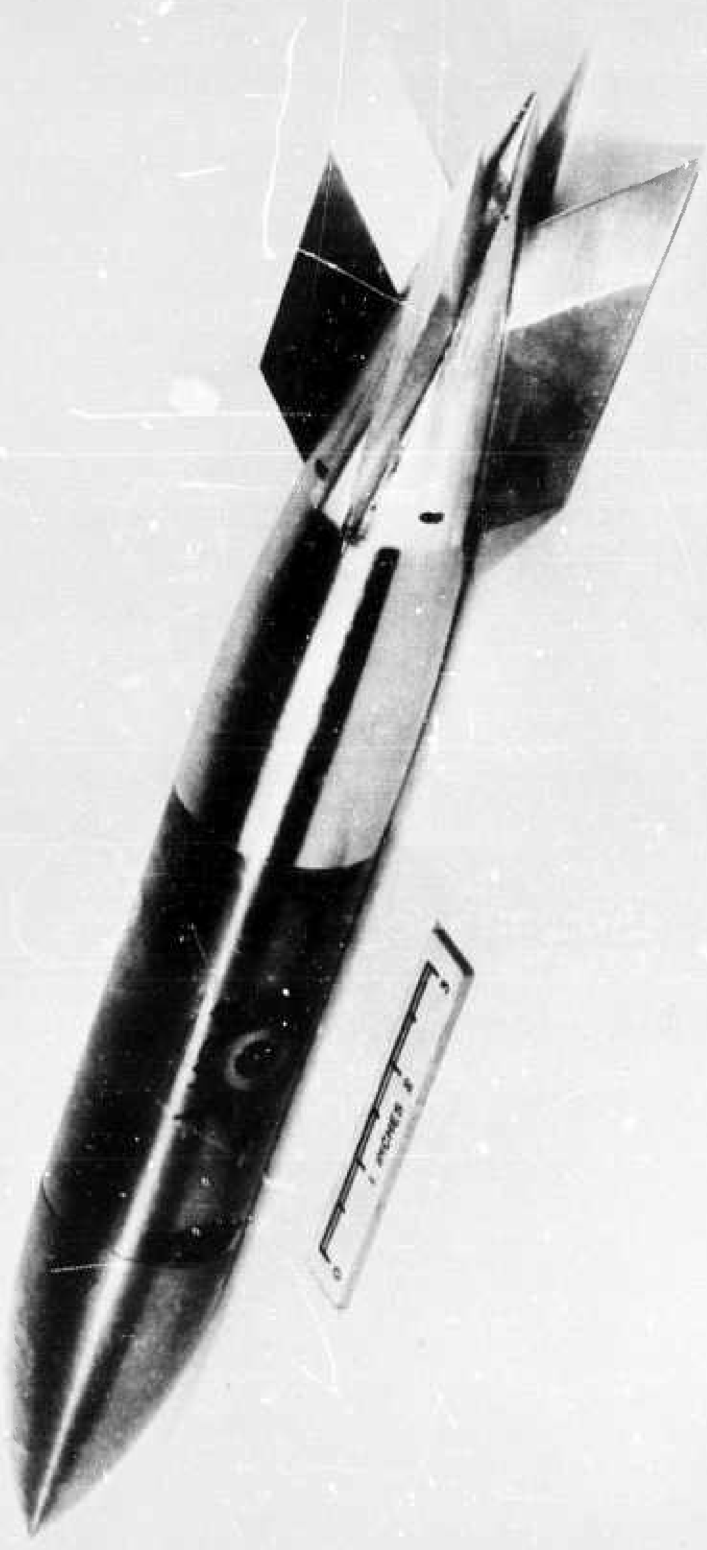

FIG. 2 HOTPOINT – LONG – CHORD MODEL

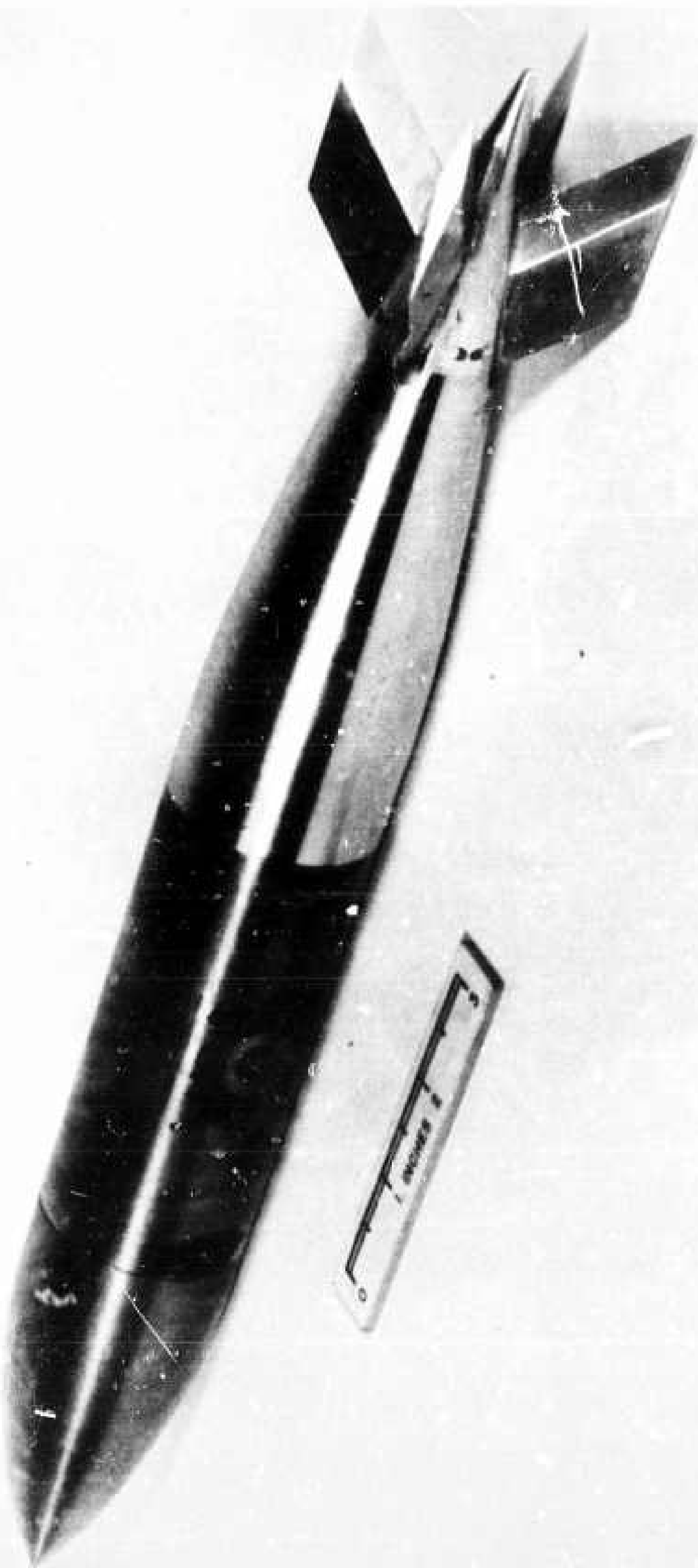

FIG. 3 HOTPOINT — SHORT-CHORD MODEL

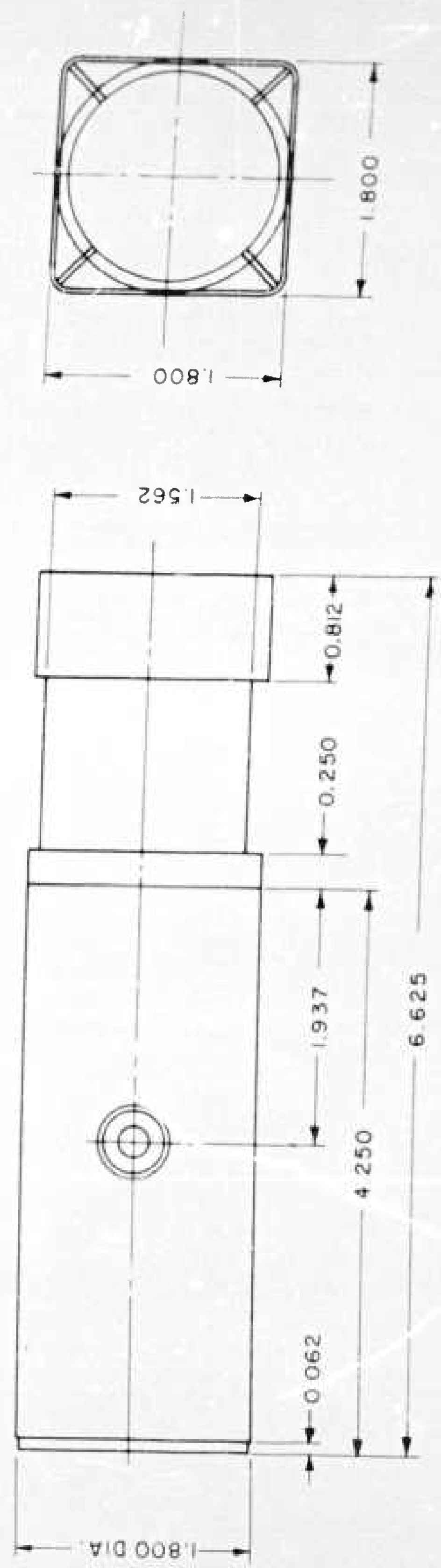

FIG. 4 HOTPOINT INTERNAL STORE

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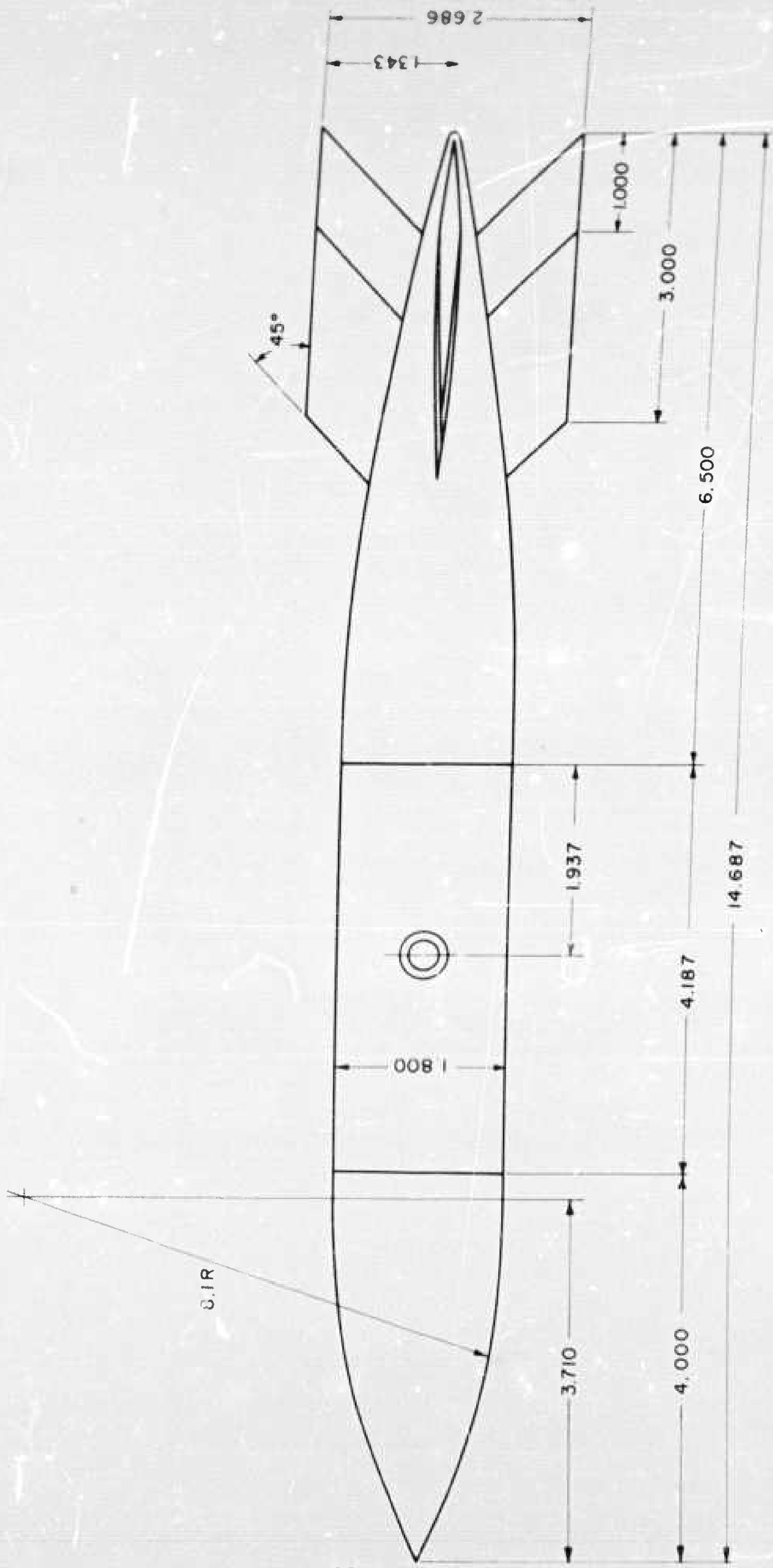

FIG. 5 LONG CHORD EXTERNAL STORE

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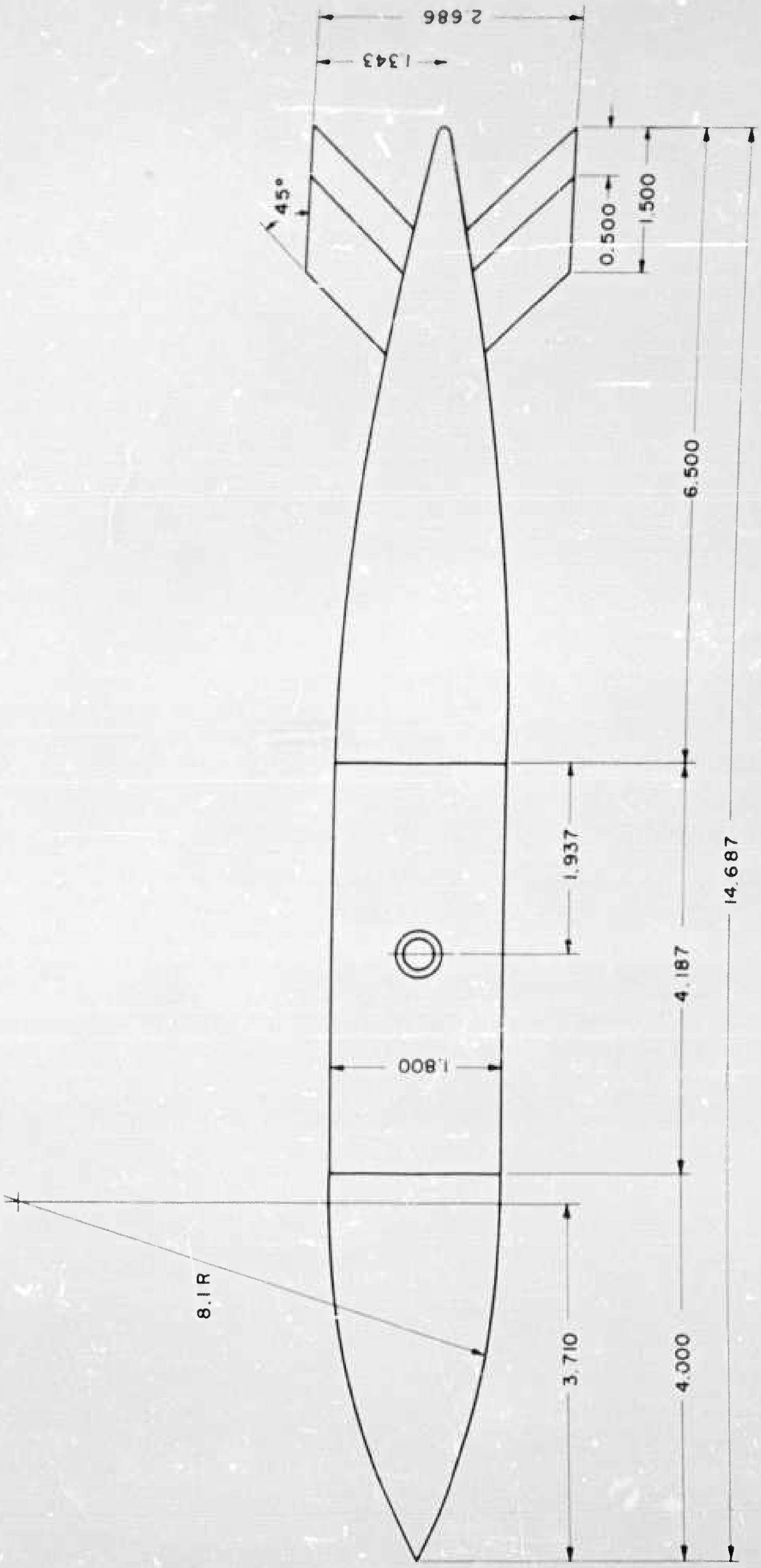

FIG. 6 SHORT CHORD EXTERNAL STORE

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